Mars Atmosphere and Volatile Evolution (MAVEN) Mission

ANCILLARY DATA

PDS Archive

Software Interface Specification

Rev. 1.2

March 16, 2015

Prepared by

Alexandria DeWolfe

alex.dewolfe@lasp.colorado.edu

Ancillary Data

PDS Archive

Software Interface Specification

Custodian:

Alexandria DeWolfe — Date
MAVEN SDC Archivist

Approved:

Raymond J. Walker — Date
PDS PPI Node Manager

Approved:

David Mitchell — Date
MAVEN SDWG Lead

Approved:

Thomas Morgan — Date
NASA PDS

Contents

List of Figures

List of Tables

1 Introduction

This software interface specification (SIS) describes the format and content of the MAVEN Ancillary Data (ANC) Planetary Data System (PDS) data archive. It includes descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline.

1.1 Distribution List

Table 1: Distribution list

Name	Organization	Email
Alexandria DeWolfe	LASP/SDC	alex.dewolfe@lasp.colorado.edu
David Mitchell	UC Berkeley SSL	mitchell@ssl.berkeley.edu
Steve Joy	UCLA/PDS/PPI	sjoy@igpp.ucla.edu
Ray Walker	UCLA/PDS/PPI	rwalker@igpp.ucla.edu
Joe Mafi	UCLA/PDS/PPI	jmafi@igpp.ucla.edu
Reta Beebe	NMSU/PDS/Atmospheres	rbeebe@nmsu.edu
Lyle Huber	NMSU/PDS/Atmospheres	lhuber@nmsu.edu
Lynn Neakrase	NMSU/PDS/Atmospheres	lneakras@nmsu.edu

1.2 Document Change Log

Table 2: Document change log

Version	Change	Date	Affected portion
0.1	Initial draft	2014-Feb-20	All
1.0	First released version	2014-Mar-24	All
1.1	Second released version	2014-Dec-02	Changes: removed TBD table added reference to Juno DRF SIS Table 8: updated schedule 5.2.1: added SASM1-3, PTE, IMU, TRK files

1.3 Abbreviations

Table 3: Abbreviations and their meaning

Abbreviation	Meaning
ASCII	American Standard Code for Information Interchange
Atmos	PDS Atmospheres Node (NMSU, Las Cruces, NM)
CCSDS	Consultative Committee for Space Data Systems
CDR	Calibrated Data Record
CFDP	CCSDS File Delivery Protocol

Abbreviation	Meaning
CK	C-matrix Kernel (NAIF orientation data)
CODMAC	Committee on Data Management, Archiving, and Computing
CRC	Cyclic Redundancy Check
CU	University of Colorado (Boulder, CO)
DAP	Data Analysis Product
DDR	Derived Data Record
DMAS	Data Management and Storage
DPF	Data Processing Facility
DRF	Data Return File
E&PO	Education and Public Outreach
EDR	Experiment Data Record
EUV	Extreme Ultraviolet; also used for the EUV Monitor, part of LPW (SSL)
FEI	File Exchange Interface
FOV	Field of View
FTP	File Transfer Protocol
GB	Gigabyte(s)
GSFC	Goddard Space Flight Center (Greenbelt, MD)
HK	Housekeeping
HTML	Hypertext Markup Language
ICD	Interface Control Document
IM	Information Model
IMU	Inertial Measurement Unit
ISO	International Standards Organization
ITF	Instrument Team Facility
IUVS	Imaging Ultraviolet Spectrograph (LASP)
JPL	Jet Propulsion Laboratory (Pasadena, CA)
LASP	Laboratory for Atmosphere and Space Physics (CU)
LID	Logical Identifier
LIDVID	Versioned Logical Identifer
LPW	Langmuir Probe and Waves instrument (SSL)

Abbreviation	Meaning
MAG	Magnetometer instrument (GSFC)
MAVEN	Mars Atmosphere and Volatile EvolutioN
MB	Megabyte(s)
MD5	Message-Digest Algorithm 5
MOI	Mars Orbit Insertion
MOS	Mission Operations System
MSA	Mission Support Area
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NGIMS	Neutral Gas and Ion Mass Spectrometer (GSFC)
NMSU	New Mexico State University (Las Cruces, NM)
NSSDC	National Space Science Data Center (GSFC)
PCK	Planetary Constants Kernel (NAIF)
PDS	Planetary Data System
PDS4	Planetary Data System Version 4
PF	Particles and Fields (instruments)
PPI	PDS Planetary Plasma Interactions Node (UCLA)
PTE	Periapsis Timing Estimator
RS	Remote Sensing (instruments)
SASM	Solar Array Switch Module
SCET	Spacecraft Event Time
SDC	Science Data Center (LASP)
SCLK	Spacecraft Clock
SEP	Solar Energetic Particle instrument (SSL)
SIS	Software Interface Specification
SOC	Science Operations Center (LASP)
SPE	Solar Particle Event
SPICE	Spacecraft, Planet, Instrument, C-matrix, and Events (NAIF data format)
SPK	Spacecraft and Planetary ephemeris Kernel (NAIF)
SSL	Space Sciences Laboratory (UCB)

Abbreviation	Meaning
STATIC	Supra-Thermal And Thermal Ion Composition instrument (SSL)
SWEA	Solar Wind Electron Analyzer (SSL)
SWIA	Solar Wind Ion Analyzer (SSL)
TBC	To Be Confirmed
TBD	To Be Determined
UCB	University of California, Berkeley
UCLA	University of California, Los Angeles
URN	Uniform Resource Name
UV	Ultraviolet
XML	eXtensible Markup Language

1.4 Glossary

Archive – A place in which public records or historical documents are preserved; also the material preserved – often used in plural. The term may be capitalized when referring to all of PDS holdings – the PDS Archive.

Basic Product – The simplest product in PDS4; one or more data objects (and their description objects), which constitute (typically) a single observation, document, etc. The only PDS4 products that are *not* basic products are collection and bundle products.

Bundle Product – A list of related collections. For example, a bundle could list a collection of raw data obtained by an instrument during its mission lifetime, a collection of the calibration products associated with the instrument, and a collection of all documentation relevant to the first two collections.

Class – The set of attributes (including a name and identifier) which describes an item defined in the PDS Information Model. A class is generic – a template from which individual items may be constructed.

Collection Product – A list of closely related basic products of a single type (e.g. observational data, browse, documents, etc.). A collection is itself a product (because it is simply a list, with its label), but it is not a *basic* product.

Data Object – A generic term for an object that is described by a description object. Data objects include both digital and non-digital objects.

Description Object – An object that describes another object. As appropriate, it will have structural and descriptive components. In PDS4 a 'description object' is a digital object – a string of bits with a predefined structure.

Digital Object – An object which consists of real electronically stored (digital) data.

Identifier – A unique character string by which a product, object, or other entity may be identified and located. Identifiers can be global, in which case they are unique across all of PDS (and its federation partners). A local identifier must be unique within a label.

Label – The aggregation of one or more description objects such that the aggregation describes a single PDS product. In the PDS4 implementation, labels are constructed using XML.

Logical Identifier (**LID**) – An identifier which identifies the set of all versions of a product.

Versioned Logical Identifier (LIDVID) – The concatenation of a logical identifier with a version identifier, providing a unique identifier for each version of product.

Manifest - A list of contents.

Metadata – Data about data – for example, a 'description object' contains information (metadata) about an 'object.'

Non-Digital Object – An object which does not consist of digital data. Non-digital objects include both physical objects like instruments, spacecraft, and planets, and non-physical objects like missions, and institutions. Non-digital objects are labeled in PDS in order to define a unique identifier (LID) by which they may be referenced across the system.

Object – A single instance of a class defined in the PDS Information Model.

PDS Information Model – The set of rules governing the structure and content of PDS metadata. While the Information Model (IM) has been implemented in XML for PDS4, the model itself is implementation independent.

Product – One or more tagged objects (digital, non-digital, or both) grouped together and having a single PDS-unique identifier. In the PDS4 implementation, the descriptions are combined into a single XML label. Although it may be possible to locate individual objects within PDS (and to find specific bit strings within digital objects), PDS4 defines 'products' to be the smallest granular unit of addressable data within its complete holdings.

Tagged Object – An entity categorized by the PDS Information Model, and described by a PDS label.

Registry – A data base that provides services for sharing content and metadata.

Repository – A place, room, or container where something is deposited or stored (often for safety).

XML – eXtensible Markup Language.

XML schema – The definition of an XML document, specifying required and optional XML elements, their order, and parent-child relationships.

1.5 MAVEN Mission Overview

The MAVEN mission is scheduled to launch on an Atlas V between November 18 and December 7, 2013. After a ten-month ballistic cruise phase, Mars orbit insertion will occur on or after September 22, 2014. Following a 5-week transition phase, the spacecraft will orbit Mars at a 75° inclination, with a 4.5 hour period and periapsis altitude of 140-170 km (density corridor of 0.05-0.15 kg/km^3). Over a one-Earth-year period, periapsis will precess over a wide range of latitude and local time, while MAVEN obtains detailed measurements of the upper atmosphere, ionosphere, planetary corona, solar wind, interplanetary/Mars magnetic fields, solar EUV and solar energetic particles, thus defining the interactions between the Sun and Mars. MAVEN will explore down to the homopause during a series of five 5-day "deep dip" campaigns for which periapsis will be lowered to an atmospheric density of 2 kg/km^3 (~125 km altitude) in order to sample the transition from the collisional lower atmosphere to the collisionless upper atmosphere. These five campaigns will be interspersed though the mission to sample the subsolar region, the dawn and dusk terminators, the anti-solar region, and the north pole.

1.5.1 Mission Objectives

The primary science objectives of the MAVEN project will be to provide a comprehensive picture of the present state of the upper atmosphere and ionosphere of Mars and the processes controlling them and to determine how loss of volatiles to outer space in the present epoch varies with changing solar conditions. Knowing how these processes respond to the Sun's energy inputs will enable scientists, for the first time, to reliably project processes backward in time to study atmosphere and volatile evolution. MAVEN will deliver definitive answers to high-priority science questions about atmospheric loss (including water) to space that will greatly enhance our understanding of the climate history of Mars. Measurements made by MAVEN will allow us to determine the role that escape to space has played in the evolution of the Mars atmosphere, an essential component of the quest to "follow the water" on Mars. MAVEN will accomplish this by achieving science objectives that answer three key science questions:

- What is the current state of the upper atmosphere and what processes control it?
- What is the escape rate at the present epoch and how does it relate to the controlling processes?
- What has the total loss to space been through time?

MAVEN will achieve these objectives by measuring the structure, composition, and variability of the Martian upper atmosphere, and it will separate the roles of different loss mechanisms for both neutrals and ions. MAVEN will sample all relevant regions of the Martian atmosphere/ionosphere system—from the termination of the well-mixed portion of the atmosphere (the "homopause"), through the diffusive region and main ionosphere layer, up into the collisionless exosphere, and through the magnetosphere and into the solar wind and downstream tail of the planet where loss of neutrals and ionization occurs to space—at all relevant latitudes and local solar times. To allow a meaningful projection of escape back in time, measurements of escaping species will be made simultaneously with measurements of the energy drivers and the controlling magnetic field over a range of solar conditions. Together with measurements of the isotope ratios of major species, which constrain the net loss to space over time, this approach will allow thorough identification of the role that atmospheric escape plays today and to extrapolate to earlier epochs.

1.5.2 Payload

MAVEN will use the following science instruments to measure the Martian upper atmospheric and ionospheric properties, the magnetic field environment, the solar wind, and solar radiation and particle inputs:

- NGIMS Package:
  - Neutral Gas and Ion Mass Spectrometer (NGIMS) measures the composition, isotope ratios, and scale heights of thermal ions and neutrals.
- RS Package:
  - Imaging Ultraviolet Spectrograph (IUVS) remotely measures UV spectra in four modes: limb scans, planetary mapping, coronal mapping and stellar occultations. These measurements provide the global composition, isotope ratios, and structure of the upper atmosphere, ionosphere, and corona.
- PF Package:
  - Supra-Thermal and Thermal Ion Composition (STATIC) instrument measures the velocity distributions and mass composition of thermal and suprathermal ions from below escape energy to pickup ion energies.
  - Solar Energetic Particle (SEP) instrument measures the energy spectrum and angular distribution of solar energetic electrons (30 keV – 1 MeV) and ions (30 keV – 12 MeV).
  - Solar Wind Ion Analyzer (SWIA) measures solar wind and magnetosheath ion density, temperature, and bulk flow velocity. These measurements are used to determine the charge exchange rate and the solar wind dynamic pressure.
  - Solar Wind Electron Analyzer (SWEA) measures energy and angular distributions of 5 eV to 5 keV solar wind, magnetosheath, and auroral electrons, as well as ionospheric photoelectrons. These measurements are used to constrain the plasma environment, magnetic field topology and electron impact ionization rate.
  - Langmuir Probe and Waves (LPW) instrument measures the electron density and temperature and electric field in the Mars environment. The instrument includes an EUV Monitor that measures the EUV input into Mars atmosphere in three broadband energy channels.
  - Magnetometer (MAG) measures the vector magnetic field in all regions traversed by MAVEN in its orbit.

1.6 SIS Content Overview

Section 2 describes the ancillary data required for science processing. Section 3 gives an overview of data organization and data flow. Section 6 describes data archive generation, delivery, and validation. Section 6.6 describes the archive structure and archive production responsibilities. Section 7 describes the file formats used in the archive, including the data product record structures. Individuals involved with generating the archive volumes are listed in Appendix A. Appendix B contains a description of the MAVEN science data file naming conventions. Appendix C, Appendix D, and Appendix E contain sample PDS product labels. Appendix F describes ANC archive product PDS deliveries formats and conventions.

1.7 Scope of this document

The specifications in this SIS apply to all ANC products submitted for archive to the Planetary Data System (PDS), for all phases of the MAVEN mission. This document includes descriptions of archive products that are produced by both the SDC and by PDS.

1.8 Applicable Documents

[1] Planetary Data System Data Provider's Handbook, TBD.

[2] Planetary Data System Standards Reference, TBD.

[3] Planetary Science Data Dictionary Document, TBD.

[4] Planetary Data System (PDS) PDS4 Information Model Specification, Version 1.1.0.1.

[5] Mars Atmosphere and Volatile Evolution (MAVEN) Science Data Management Plan, Rev. C, doc. no.MAVEN-SOPS-PLAN-0068.

[6] King, T., and J. Mafi, Archive of MAVEN CDF in PDS4, July 16, 2013.

[7] Juno Software Interface Specification: Data Return File (DRF): SIS_DRF_MVN.pdf

1.9 Audience

This document serves both as a SIS and Interface Control Document (ICD). It describes both the archiving procedure and responsibilities, and data archive conventions and format. It is designed to be used both by the instrument teams in generating the archive, and by those wishing to understand the format and content of the ANC PDS data product archive collection. Typically, these individuals would include scientists, data analysts, and software engineers.

2 ANC Data Description

The ancillary data to be archived includes two different datasets: all spacecraft and instrument data which is required for science processing, and a time-ordered list of mission events. This dataset does not include science data from the instruments, which will be archived in the instrument archives, or SPICE kernels, which are archived separately at NAIF. Due to ITAR restrictions, this archive does not include all spacecraft and instrument housekeeping data, but only that which is applicable to the science processing. MAVEN was granted an ITAR 125.4(b)(13) exemption by the GSFC Export Control Office for spacecraft and instrument engineering data that is needed for science processing. Descriptions of instrument and spacecraft calibration are covered in the instrument SISs and the spacecraft documentation

MAVEN spacecraft and ancillary data files are contained in Data Return Files (DRFs), which are ASCII files generated by the Mission Support Area and delivered to the Science Operations Center (SOC) for distribution to the MAVEN team.

The MAVEN Mission Events List will be captured in a set of ASCII files generated from a database stored at the SDC. Events include spacecraft and instrument events collected by the Payload Operations Center (POC), and geophysical events submitted by the science team.

2.1 Measured Parameters

The complete set of ancillary data to be used for science processing is documented in MVN-OIA-21 .

A list of events to be collected in the Mission Events List is given in the table below, with the caveat that part of the point of the event list is to capture unexpected events that may affect the science data. There are two types of events: those that are collected by the POC, either routinely or intermittently in the case of anomalies, and external events not related to the spacecraft and instrument operations which may have some impact on the science data. These external events are collected and input in the database by the MAVEN science team. This list is not intended to be exhaustive, but is intended as a useful reference in case of unexplained quirks in the science data.

Event type	Source
permanent data gaps	GAP reports
instrument power on/off	Integrated Report (IR)
instrument zone enter/exit	IR
desats start/stop	IR
thruster firings start/stop	IR
MAG roll maneuvers start/stop	IR
S/C slew start/stop	IR
Communications support start/stop	IR
Relay start/stop	IR

orbit start/stop	IR
periapse segment start/stop	IR
out-bound segment start/stop	IR
apoapse segment start/stop	IR
in-bound segment start/stop	IR
IUVS occultation start/stop	IR
S/C safe hold entry/exit	manual entry
DSN outage start/stop	manual entry
eclipse entry/exit	Reconstructed ephemeris
Comet flybys	manual entry
MAVEN shock crossings	manual entry
SEP events	manual entry
Solar flare Mars dust storms	manual entry manual entry

.

3 Data Overview

This section provides a high level description of archive organization under the PDS4 Information Model (IM) as well as the flow of the data from the spacecraft through delivery to PDS. Unless specified elsewhere in this document, the MAVEN ANC archive conforms with version 1.1.0.1 of the PDS4 IM [4].

3.1 Data Processing Levels

A number of different systems may be used to describe data processing level. This document refers to data by their PDS4 processing level. Table 4 provides a description of these levels along with the equivalent designations used in other systems.

Table 4: Data processing level designations

PDS4 processing level	PDS4 processing level description	MAVEN Processing Level	CODMAC Level	NASA Level
Raw	Original data from an instrument. If compression, reformatting, packetization*, or other translation has been applied to facilitate data transmission or storage, those processes are reversed so that the archived data are in a PDS approved archive format.	0	1	0
Reduced	Data that have been processed beyond the raw stage but which are not yet entirely independent of the instrument.	1	2	1A
Calibrated	Data converted to physical units entirely independent of the instrument.	2	3	1B
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.	3+	4+	2+

* PDS does not accept packetized data (CODMAC level 1/NASA level 0) as fulfilling the requirement for the archive of raw data. The PDS/PPI node, however, has agreed to an exception for the MAVEN mission with the understanding that the MAVEN packetized data are not compressed, and may be described as fixed width binary tables. Typically the minimum reduction level accepted by PDS for "raw" data is CODMAC level 2, or NASA level 1A.

3.2 Products

A PDS product consists of one or more digital and/or non-digital objects, and an accompanying PDS label file. Labeled digital objects are data products (i.e. electronically stored files). Labeled non-digital objects are physical and conceptual entities which have been described by a PDS label. PDS labels provide identification and description information for labeled objects. The PDS label defines a Logical Identifier (LID) by which any PDS labeled product is referenced throughout the system. In PDS4 labels are XML formatted ASCII files. More information on the formatting of PDS labels is provided in Section 7.1.7. More information on the usage of LIDs and the formation of MAVEN LIDs is provided in Section 6.7.

3.3 Product Organization

The highest level of organization for PDS archive is the bundle. A bundle is a list of one or more related collection products which may be of different types. A collection is a list of one or more related basic products which are all of the same type. Figure 1 below illustrates these relationships.

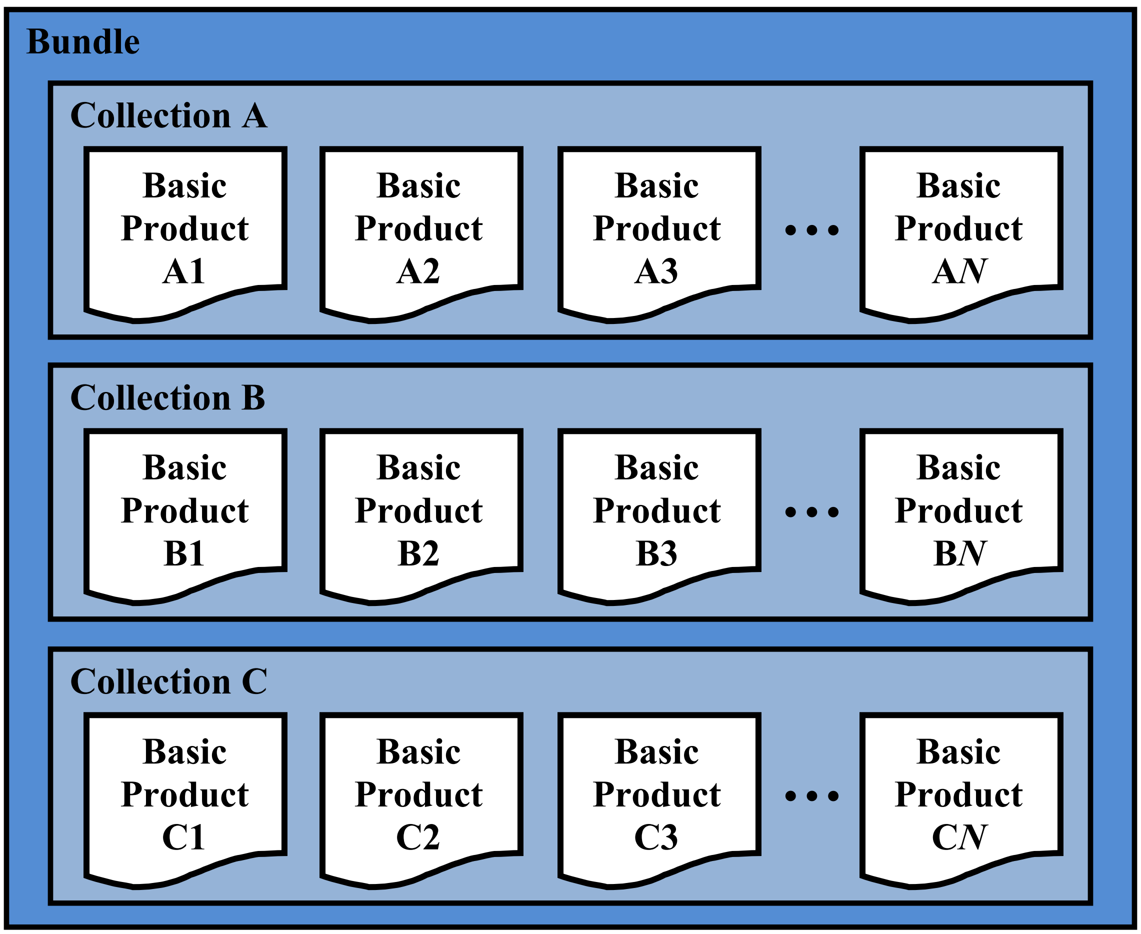

Figure 1: A graphical depiction of the relationship among bundles, collections, and basic products.

Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization. Bundle and collection membership is established by a member inventory list. Bundle member inventory lists are provided in the bundle product labels themselves. Collection member inventory lists are provided in separate collection inventory table files. Sample bundle and collection labels are provided in Appendix C and Appendix D, respectively.

3.3.1 Collection and Basic Product Types

Collections are limited to a single type of basic products. The types of archive collections that are defined in PDS4 are listed in Table 5.

Table 5: Collection product types

Collection Type	Description
Browse	Contains products intended for data characterization, search, and viewing, and not for scientific research or publication.
Calibration	Contains data and files necessary for the calibration of basic products.
Context	Contains products which provide for the unique identification of objects which form the context for scientific observations (*e.g.* spacecraft, observatories, instruments, targets, etc.).
Document	Contains electronic document products which are part of the PDS Archive.
Data	Contains scientific data products intended for research and publication.
SPICE	Contains NAIF SPICE kernels.
XML_Schema	Contains XML schemas and related products which may be used for generating and validating PDS4 labels.

3.4 Bundle Products

The ANC data archive is organized into two bundles. A description of each bundle is provided in Table 6. A more detailed description of the contents and format of each bundle is provided in Section 6.8.

Table 6: ANC Bundles

Bundle Logical Identifier	PDS4 Reduction Level	Description	Data Provider

	Bundle Logical Identifier	PDS4 Reduction Level	Description	Data Provider
4	urn:nasa:pds:maven.anc.drf	Calibrated	All ancillary DRF files.	SDC

	Bundle Logical Identifier	PDS4 Reduction Level	Description	Data Provider
5	urn:nasa:pds:maven.anc.events	Document	Mission Event List	SDC

5.1 Data Flow

This section describes only those portions of the MAVEN data flow that are directly connected to archiving. A full description of MAVEN data flow is provided in the MAVEN Science Data Management Plan [5]. A graphical representation of the full MAVEN data flow is provided in Figure 2 below.

The ancillary DRF files will be generated by the Mission Support Area (MSA) and delivered to the Science Operations Center (SOC) on a regular basis beginning at launch and continuing throughout the mission. During the mapping phase, deliveries will be made biweekly with the science data. The SOC makes no changes to these files, but delivers them directly to the ITFs for science processing, and to the PDS for archiving.

The event database will be updated with automated data from the POC weekly, after receipt of all data from the MSA needed to generate events. Events will be generated from reconstructed data rather than predicts. Geophysical events will be added as they happen.

The SOC will maintain an active archive of all ancillary MAVEN data required for science processing, and will provide the MAVEN science team with direct access through the life of the MAVEN mission. After the end of the MAVEN project, PDS will be the sole long-term archive for all public MAVEN data.

Data bundles intended for the archive are identified in Table 6.

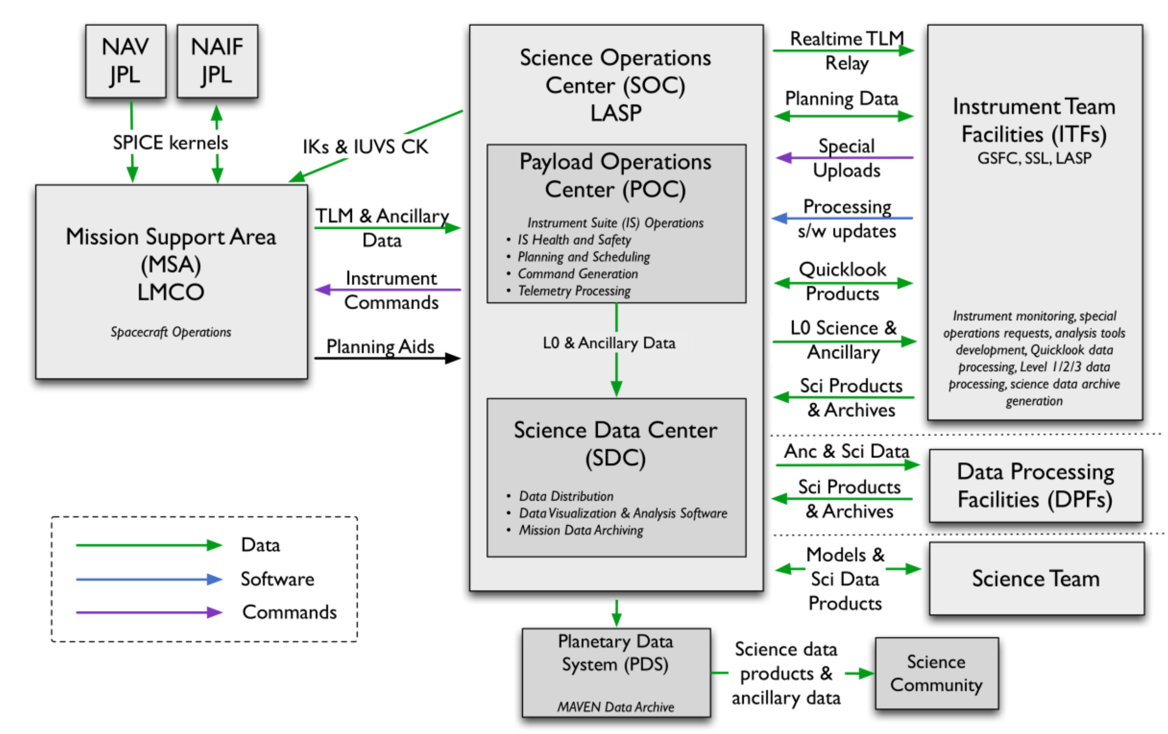

Figure 2: MAVEN Ground Data System responsibilities and data flow. Note that this figure includes portions of the MAVEN GDS which are not directly connected with archiving, and are therefore not described in Section 5.1 above.

6 Archive Generation

The ANC archive products are produced by the MSA and SOC with the support of the PDS Planetary Plasma Interactions (PPI) Node at the University of California, Los Angeles (UCLA). The archive volume creation process described in this section sets out the roles and responsibilities of each of these groups. The assignment of tasks has been agreed upon by all parties. Archived data received by the PPI Node from the SOC are made available to PDS users electronically as soon as practicable but no later two weeks after the delivery and validation of the data.

6.1 Data Processing and Production Pipeline

The following sections describe the process by which data products in each of the ANC bundles listed in Table 7 are produced.

6.1.1 PDS Peer Review

The PPI node will conduct a full peer review of all of the data types in the ANC archive. The review data will consist of fully formed bundles populated with candidate final versions of the data and other products and the associated metadata.

Table 7: MAVEN PDS review schedule

Date	Activity	Responsible Team
2014-May through 2014-Aug	Calibrated and derived data product, archive structure, and SIS peer review	SDC
2014-Nov-15	Start of Science Operations	
2015-Mar-16	Delivery #1 Due to PDS: Calibrated & Derived 2014-11-15 – 2015-02-15 plus cruise data and calibrations	ITF/SDC
2015-Mar through 2015-Apr	Calibrated and derived data peer review	PDS
2015-May-15	Delivery #1 Release to the Public (Start of Science Ops + 6 months)	PDS
2015-Jul-29	Delivery #2 Due to PDS: Calibrated & Derived: 2015-02-16 – 2015-05-15	ITF/SOC
2015-Aug-14	Delivery #2 Release	PDS
2015-Oct-30	Delivery #3 Due to PDS: Calibrated & Derived: 2015-05-16 – 2015-08-15	ITF/SOC
2015-Nov-16	Delivery #3 Release	PDS
2016-Jan-29	Delivery #4 Due to PDS: Calibrated & Derived: 2015-08-16 – 2015-11-15	ITF/SOC
2016-Feb-15	Delivery #4 Release	PDS
2016-Apr-15	Delivery #5 Due to PDS: Raw: Launch through EOM	ITF/SOC
2016-May-16	Delivery #5 Release	PDS

Reviews will include a preliminary delivery of sample products for validation and comment by PDS PPI and Engineering node personnel. The data provider will then address the comments coming out of the preliminary review, and generate a full archive delivery to be used for the peer review.

Reviewers will include MAVEN Project and SOC representatives, researchers from outside of the MAVEN project, and PDS personnel from the Engineering and PPI nodes. Reviewers will examine the sample data products to determine whether the data meet the stated science objectives of the instrument and the needs of the scientific community and to verify that the accompanying metadata are accurate and complete. The peer review committee will identify any liens on the data that must be resolved before the data can be 'certified' by PDS, a process by which data are made public as minor errors are corrected.

In addition to verifying the validity of the review data, this review will be used to verify that the data production pipeline by which the archive products are generated is robust. Additional deliveries made using this same pipeline will be validated at the PPI node, but will not require additional external review.

As expertise with the instrument and data develops the SOC may decide that changes to the structure or content of its archive products are warranted. Any changes to the archive products or to the data production pipeline will require an additional round of review to verify that the revised products still meet the original scientific and archival requirements or whether those criteria have been appropriately modified. Whether subsequent reviews require external reviewers will be decided on a case-by-case basis and will depend upon the nature of the changes. A comprehensive record of modifications to the archive structure and content is kept in the Modification_History element of the collection and bundle products.

The instrument team and other researchers are encouraged to archive additional ANC products that cover specific observations or data-taking activities. The schedule and structure of any additional archives are not covered by this document and should be worked out with the PPI node.

6.2 Data Transfer Methods and Delivery Schedule

The SOC is responsible for delivering data products to the PDS for long-term archiving. While ITFs are primarily responsible for the design and generation of calibrated and derived data archives, the archival process is managed by the SOC. The SOC (in coordination with the ITFs) will also be primarily responsible for the design and generation of the raw data archive. The first PDS delivery will take place within 6 months of the start of science operations. Additional deliveries will occur every following 3 months and one final delivery will be made after the end of the mission. Science data are delivered to the PDS within 6 months of its collection. If it becomes necessary to reprocess data which have already been delivered to the archive, the ITFs will reprocess the data and deliver them to the SDC for inclusion in the next archive delivery. A summary of this schedule is provided in Table 8 below.

Table 8: Archive bundle delivery schedule

Bundle Logical Identifier	First Delivery to PDS	Delivery Schedule	Estimated Delivery Size
urn:nasa:pds:maven.anc.drf:	No later than 6 months after the start of science operations	Every 3 months	4 GB
urn:nasa:pds:maven.anc.events:	No later than 6 months after the	Every 3 months	< 1 GB

	start of science operations		

Each delivery will comprise both data and ancillary data files organized into directory structures consistent with the archive design described in Section 6.6, and combined into a deliverable file(s) using file archive and compression software. When these files are unpacked at the PPI Node in the appropriate location, the constituent files will be organized into the archive structure.

Archive deliveries are made in the form of a "delivery package". Delivery packages include all of the data being transferred along with a transfer manifest, which helps to identify all of the products included in the delivery, and a checksum manifest which helps to insure that integrity of the data is maintained through the delivery. The format of these files is described in Section 7.3.

Data are transferred electronically (using the *ssh* protocol) from the SOC to an agreed upon location within the PPI file system. PPI will provide the SOC a user account for this purpose. Each delivery package is made in the form of a compressed *tar* or *zip* archive. Only those files that have changed since the last delivery are included. The PPI operator will decompress the data, and verify that the archive is complete using the transfer and MD5 checksum manifests that were included in the delivery package. Archive delivery status will be tracked using a system defined by the PPI node.

Following receipt of a data delivery, PPI will reorganize the data into its PDS archive structure within its online data system. PPI will also update any of the required files associated with a PDS archive as necessitated by the data reorganization. Newly delivered data are made available publicly through the PPI online system once accompanying labels and other documentation have been validated. It is anticipated that this validation process will require no more than fourteen working days from receipt of the data by PPI. However, the first few data deliveries may require more time for the PPI Node to process before the data are made publicly available.

The MAVEN prime mission begins approximately 5 weeks following MOI and lasts for 1 Earth-year. Table 8 shows the data delivery schedule for the entire mission.

6.3 Data Product and Archive Volume Size Estimates

ANC data products consist of files that span one UT day. Files vary in size depending on the telemetry rate and allocation; the maximum single file size is generally about 5 MB. A single archive delivery will span three months, with 11 files each day, adding up to a total volume per delivery of approximately 4 GB.

Event files will span one month and be labeled as such in the filename. Filesize will vary depending on the number of events that actually occur, but as files are intended to be human-readable ASCII files they will not be excessively large.

6.4 Data Validation

Routine data deliveries to the PDS are validated at the PPI node to ensure that the delivery meets PDS standards, and that the data conform to the SIS as approved in the peer review. As long as there are no changes to the data product formats, or data production pipeline, no additional external review will be conducted.

6.5 Backups and duplicates

The PPI Node keeps three copies of each archive product. One copy is the primary online archive copy, another is an onsite backup copy, and the final copy is an off-site backup copy. Once the archive products are fully validated and approved for inclusion in the archive, copies of the products are sent to the National Space Science Data Center (NSSDC) for long-term archive in a NASA-approved deep-storage facility. The PPI Node may maintain additional copies of the archive products, either on or off-site as deemed necessary. The process for the dissemination and preservation of ANC data is illustrated in Figure 3.

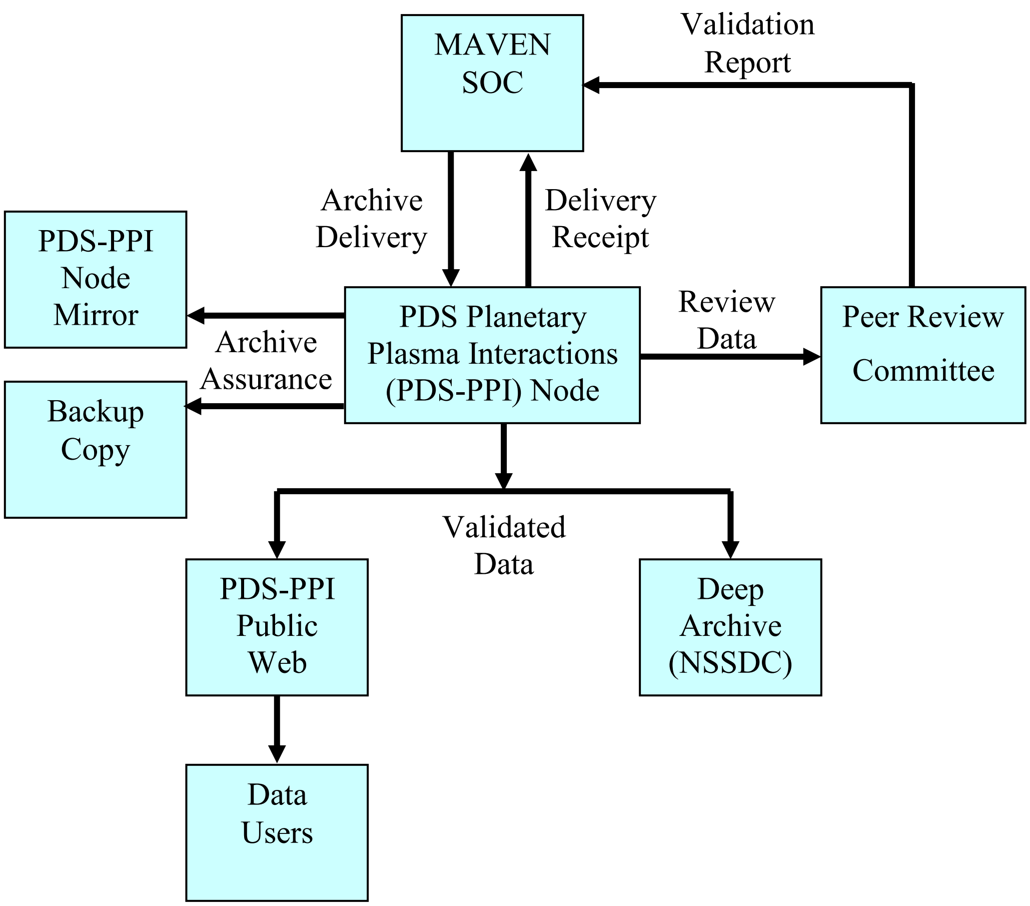

Figure 3: Duplication and dissemination of ANC archive products at PDS/PPI.

6.6 Archive organization and naming

This section describes the basic organization of an ANC bundle, and the naming conventions used for the product logical identifiers, and bundle, collection, and basic product filenames.

6.7 Logical Identifiers

Every product in PDS is assigned an identifier which allows it to be uniquely identified across the system. This identifier is referred to as a Logical Identifier or LID. A LIDVID (Versioned

Logical Identifier) includes product version information, and allows different versions of a specific product to be referenced uniquely. A product's LID and VID are defined as separate attributes in the product label. LIDs and VIDs are assigned by the entity generating the labels and are formed according to the conventions described in sections 6.7.1 and 6.7.2 below. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools.

6.7.1 LID Formation

LIDs take the form of a Uniform Resource Name (URN). LIDs are restricted to ASCII lower case letters, digits, dash, underscore, and period. Colons are also used, but only to separate prescribed components of the LID. Within one of these prescribed components dash, underscore, or period are used as separators. LIDs are limited in length to 255 characters.

MAVEN ANC LIDs are formed according to the following conventions:

- Bundle LIDs are formed by appending a bundle specific ID to the MAVEN [INST] base ID:

  urn:nasa:pds:maven.anc.<bundle ID>

  Since all PDS bundle LIDs are constructed this way, the combination of maven.anc.bundle must be unique across all products archived with the PDS.

- Collection LIDs are formed by appending a collection specific ID to the collection's parent bundle LID:

  urn:nasa:pds:maven.anc.<bundle ID>:<collection ID>

  Since the collection LID is based on the bundle LID, which is unique across PDS, the only additional condition is that the collection ID must be unique across the bundle. Collection IDs correspond to the collection type (e.g. "browse", "data", "document", etc.). Additional descriptive information may be appended to the collection type (e.g. "data-raw", "data-calibrated", etc.) to insure that multiple collections of the same type within a single bundle have unique LIDs.

- Basic product LIDs are formed by appending a product specific ID to the product's parent collection LID:

  urn:nasa:pds:maven.anc.<bundle ID>:<collection ID>:<product ID>

  Since the product LID is based on the collection LID, which is unique across PDS, the only additional condition is that the product ID must be unique across the collection. Product IDs are based on the filenames, e.g. sci_anc_eps14_061_062:

sci_anc	ancillary data for science use
eps	ancillary data type (see Table 9)
14	2-digit year (14 = 2014)
061_062	3-digit day of year; files span either one or two days

A list of ANC bundle LIDs is provided in Table 6. Collection LIDs are listed in Table 9.

6.7.2 VID Formation

Product version ID's consist of major and minor components separated by a "." (M.n). Both components of the VID are integer values. The major component is initialized to a value of "1", and the minor component is initialized to a value of "0". The minor component resets to "0" when the major component is incremented.

6.8 ANC Archive Contents

The ANC archive includes the two bundles listed in Table 6. The following sections describe the contents of each of these bundles in greater detail.

6.8.1 ANC DRF Bundle

The DRF bundle contains all ancillary files generated by the MSA, containing ancillary spacecraft and instrument data in the DRF format as defined by the MAVEN DRF SIS. There are eleven such files generated for each day of the mission. Each is a time-ordered ASCII table divided into columns, where each column is a telemetry channel. There will be one collection for each of these eleven files, which are identified in Table 10. The filename convention for these files is

sci_anc_<type><YY>_<DOY1>_<DOY2>.drf

where <type> is one of the following:

Table 9: DRF file type and ANC collections

Filetype	Description	**Collection LID**
eps	Electrical Power System	urn:nasa:pds:maven.anc.drf.eps
gnc	Guidance Navigation and Control	urn:nasa:pds:maven.anc.drf.gnc
ngms	NGIMS instrument data	urn:nasa:pds:maven.anc.drf.ngms
pf	PF instrument data	urn:nasa:pds:maven.anc.drf.pf
rs	RS instrument data	urn:nasa:pds:maven.anc.drf.rs
usm1	Universal Switching Module 1	urn:nasa:pds:maven.anc.drf.usm1
usm2	Universal Switching Module 2	urn:nasa:pds:maven.anc.drf.usm2
usm3	Universal Switching Module 3	urn:nasa:pds:maven.anc.drf.usm3
usm4	Universal Switching Module 4	urn:nasa:pds:maven.anc.drf.usm4
usm5	Universal Switching Module 5	urn:nasa:pds:maven.anc.drf.usm5
usm6	Universal Switching Module 6	urn:nasa:pds:maven.anc.drf.usm6
sasm1	Solar Array Switch Module	urn:nasa:pds:maven.anc.drf.sasm1
sasm2		urn:nasa:pds:maven.anc.drf.sasm2
sasm3		urn:nasa:pds:maven.anc.drf.sasm3
pte	Periapsis Timing Estimator	urn:nasa:pds:maven.anc.drf.pte
imu	Inertial Measurement Unit	urn:nasa:pds:maven.anc.drf.imu

6.8.1.1 ANC DRF Collection Contents

Each collection is effectively the same, varying only in the contents of the DRF files.

6.8.1.2 ANC DRF Document Collection

The ANC DRF document collection contains documents which are useful for understanding and using the ANC DRF bundle. Table 10 contains a list of the documents included in this collection, along with the LID, and responsible group. Following this a brief description of each document is also provided.

Table 10: ANC Calibrated Science Data Documents

Document Name	LID	Responsiblility
MAVEN Science Data Management Plan	urn:nasa:pds:maven:document:sdmp	MAVEN Project
MAVEN ANC Archive SIS	urn:nasa:pds:maven.anc:document:SIS	SOC
MAVEN Mission Description	urn:nasa:pds:maven:document:mission.description	MAVEN Project
MAVEN Spacecraft Description	urn:nasa:pds:maven:document:spacecraft.description	MAVEN Project
MAVEN DRF SIS	urn:nasa:pds:maven.msa:document:DRF.SIS	MSA

MAVEN Science Data Management Plan – describes the data requirements for the MAVEN mission and the plan by which the MAVEN data system will meet those requirements

MAVEN ANC Archive SIS – describes the format and content of the ANC PDS data archive, including descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline (this document)

MAVEN Mission Description – describes the MAVEN mission.

MAVEN Spacecraft Description – describes the MAVEN spacecraft.

DRF SIS – describes the DRF document format.

While responsibility for the individual documents varies, the document collection itself is managed by the PDS/PPI node.

6.8.2 ANC Events

The ANC Events bundle contains time-ordered ASCII files listing all mission events. These files are generated by querying a database at the SDC.

Table 11: ANC Events collections

Collection LID	Description
urn:nasa:pds:maven.anc.events.all	All mission events in a single ASCII file for the three-month time range covered by each delivery.

6.8.2.1 ANC Events All

This collection contains all event files. These files are ASCII tables in which the first column is the event start time in UTC. The filename convention will include the date range covered by each file. The data will be tab-separated ASCII with column headings for each column. The contributor responsible for each event will be identified in the data. These files will be generated by the SDC, which is responsible for distributing and archiving them.

7 Archive product formats

Data that comprise the ANC archives are formatted in accordance with PDS specifications [see *Planetary Science Data Dictionary* [4], *PDS Data Provider's Handbook* [2], and *PDS Standards Reference* [3]. This section provides details on the formats used for each of the products included in the archive.

7.1 Data File Formats

This section describes the format and record structure of each of the data file types.

The ANC DRF data product is an ASCII data file with an attached header followed by a time series (table). The header internally documents the file contents. Each file also is described by a PDS label file (*.xml).

7.1.1 EPS DRF data file structure

Table 12: EPS DRF data file record structure.

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
SA1pyISC	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 07. SASM 1 +Y ISC current. In DN and EU.
SASM_TotalC	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 13. In DN and EU.
SA2myISC	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 22. SASM -Y ISC current. In DN and EU.

7.1.2 GNC DRF data file structure

Table 13: GNC DRF data file record structure

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
ATT_QU_I2B_1, ATT_QU_I2B_2, ATT_QU_I2B_3, ATT_QU_I2B_4	The 4 elements of current spacecraft attitude quaternion based on the current AD state running, phased as inertial to body.
ATT_QU_I2B_T	ADS spacecraft time stamp (SCLK) of current spacecraft attitude quaternion based on the current AD state running, phased as inertial to body.
ATT_RAT_BF_X, ATT_RAT_BF_Y, ATT_RAT_BF_Z	The current spacecraft angular rates in the spacecraft body frame based on the current AD state running.
APIG_ANGLE	The APP (articulated payload platform) measured inner gimbal axis angle for the sensor in use on the inner gimbal axis.
APOG_ANGLE	The APP (articulated payload platform) measured outer gimbal axis angle for the sensor in use on the outer gimbal axis.

APIG_APP_RAT	The measured APP (articulated payload platform) inner gimbal axis rate for the sensor in use on the inner gimbal axis.
APOG_APP_RAT	The measured APP (articulated payload platform) outer gimbal axis rate for the sensor in use on the outer gimbal axis.
RW1_SPD_DGTL RW2_SPD_DGTL, RW3_SPD_DGTL, RW4_SPD_DGTL	The reaction wheel rotational speed as determined by digital tachometer and filtered with a configurable digital speed filter. Data is returned in engineering units (rad/sec) and reflects both positive and negative rotation.
ACC_BOD_VECX, ACC_BOD_VECY, ACC_BOD_VECZ	The X, Y, and Z-axis component of spacecraft linear acceleration as measured by the IMUs in the spacecraft body frame.
RW1_SPD_PTE, RW2_SPD_PTE, RW3_SPD_PTE, RW4_SPD_PTE	Reaction wheel 1-4 rotational speeds as determined by digital tachometer and filtered with a configurable digital speed for PTE filter. Data is returned in engineering units (rad/sec) and reflects both positive and negative rotation.

7.1.3 NGMS DRF data file structure

Table 14: NGMS DRF data file record structure

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
NGM_AGC_T	The NGM engineering data, AGC temperature (derived into EU).
NGM_DET_T	The NGM engineering data, DET board temperature (derived into EU).
NGM_RF_T	The NGM engineering data, RF board temperature (derived into EU).
NGM_CDH_T	The NGM engineering data, CDH board temperature (derived into EU).
NGM_CTL_T	The NGM engineering data, CTL board temperature (derived into EU).
NGM_PS_T	The NGM engineering data, PS board temperature (derived into EU).
NGM_AGC_TdN	The NGM engineering data, AGC temperature (in DN).
NGM_DET_Tdn	The NGM engineering data, DET board temperature (in DN).
NGM_RF_Tdn	The NGM engineering data, RF board temperature (in DN).
NGM_CDH_Tdn	The NGM engineering data, CDH board temperature (in DN).
NGM_CTL_Tdn	The NGM engineering data, CTL board temperature (in DN).
NGM_PS_Tdn	The NGM engineering data, PS board temperature (in DN).

NgmInMe1Tcio	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 40. NGIMS internal MEB 1 temperature. Corresponds to C-0240 (NgmInMe1Tcio). In DN and EU.
NgmInBk1T, NgmInBk2T	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 51. NGIMS internal bakeout 1 temperature. Corresponds to C-0251 (NgmInBk1Tcio). In DN and EU.
NgmInMe2Tcio	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 46. NGIMS internal MEB 2 temperature. Corresponds to C-0446 (NgmInMe2Tcio). In DN and EU.

7.1.4 PF DRF data file structure

Table 15: PF DRF data file record structure

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
SP_PF_PFull	The percent of the the downlink managed MMM soft partition assigned to PF (particles and fields) data that is full on not sent data.
PfpBpT1	PFDPU baseplate temperatures in DN and EU. CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 16. PFDPU baseplate temperature 1. Corresponds to C-0216 (PfpBpT1cio).
StatInT1	STATIC internal temperatures in DN and EU. CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 21. STATIC internal temperature 1. Corresponds to C-0221 (StatInT1cio).
Pfp1InT	PFDPU 1 internal temperatures in DN and EU. CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 27. PFDPU 1 internal temperature.
SweaInT1	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 34. SWEA internal temperature 1. Corresponds to C-0234 (SweaInT1cio). In DN and EU.
Sep1InT1	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 36. SEP 1 internal temperature 1. Corresponds to C-0236 (Sep1InT1cio). In DN and EU.
EuvInT1	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 39. EUV internal temperature 1. Corresponds to C-0239 (EuvInT1cio). In DN and EU.
Lpw2BomT1	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 42. LPW 2 boom temperature 1. Corresponds to C-0242 (Lpw2BomT1cio). In DN and EU.
Lpw1BomT1	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 50. LPW 1 boom temperature 1. Corresponds to C-0250 (Lpw1BomT1cio). In DN and EU.

Sep2InT1	CDH AAC 1 (analog acquisition card 1) AIP (analog input passive) channel 61. SEP 2 internal temperature 1. Corresponds to C-0261 (Sep2InTcio). In DN and EU.
PfpBpT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 16. PFDPU baseplate temperature 1. Corresponds to C-0416 (PfpBpT2cio). In DN and EU.
SwiaInT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 28. SWIA internal temperature 2. Corresponds to C-0428 (SwiaInT2cio). In DN and EU.
SweaInT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 30. SWEA internal temperature 2. Corresponds to C-0430 (SweaInT2cio). In DN and EU.
StatInT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 32. STATIC internal temperature 2. Corresponds to C-0432 (StatInT2cio). In DN and EU.
Sep1InT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 34. SEP 1 internal temperature 2. Corresponds to C-0434 (Sep1InT2cio). In DN and EU.
EuvInT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 37. EUV internal temperature 2. Corresponds to C-0437 (EuvInT2cio). In DN and EU.
Pfp2InT	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 39. PFDPU 2 internal temperature. In DN and EU.
Lpw1BomT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 40. LPW 1 boom temperature 2. Corresponds to C-0440 (Lpw2BomT2cio). In DN and EU.
Sep2InT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 54. SEP 2 internal temperature 2. Corresponds to C-0454 (Sep2InT2cio). In DN and EU.
Lpw2BomT2	CDH AAC 2 (analog acquisition card 2) AIP (analog input passive) channel 58. LPW 2 boom temperature 2. Corresponds to C-0458 (Lpw2BomT2cio). In DN and EU.
Mag1InT	CDH AAC 1 (analog acquisition card 1) AIV (analog input voltage) channel 26. MAG 1 internal temperature in EU (see T-0326 for the DN value).
Mag2InT	CDH AAC 2 (analog acquisition card 2) AIV (analog input voltage) channel 31. MAG 2 internal temperature in EU (see T-0531 for the DN value).
Bus28V_1_V Bus28V_2_V	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 12 and 27. Bus 28V voltage 1 and voltage 2 signal. In DN and EU.
Mag1HtrMonV Mag2HtrMonV	CDH AAC 1 (analog acquisition card 1) AIV (analog input voltage) channel 26. MAG 1 heater monitor voltage. CDH AAC 2 (analog acquisition card 2) AIV (analog input voltage) channel 31. MAG 2 heater monitor voltage. In DN and EU.

7.1.5 RS DRF data file structure

Table 16: RS DRF data file record structure

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
RspInSrT1, RspInSrT2	RSDPU internal survival temperatures.
IuvsInST1, IuvsInST2	IUVS internal survival temperatures.

7.1.6 USM DRF data file structure

The USM DRF files contain switch status information. The list of telemetry names in each file is given here; complete descriptions are in the USM_tlm_names.xlsx spreadsheet which will be archived with the USM collection.

Table 17: USM DRF data file record structure

USM1	USM2	USM3	USM4	USM5	USM6
USM1usD0_POS	USM2usD0_POS	USM3usD0_POS	USM4usD0_POS	USM5usD0_POS	USM6usD0_POS
POS_TcmTCbH1	POS_TcmTCbH2	POS_SWEAinPH	POS_SWEAinSH	POS_Batt2iH1	POS_Batt2iH2
POS_RWA2_PH	POS_RWA2_SH	POS_STATinPH	POS_STATinSH	POS_USM5_L01	POS_USM6_L01
POS_ST_1	POS_ST_2	POS_PrTnkPH2	POS_PrTnkSH2	POS_Tv1278PH	POS_Tv1278SH
USM1usD1_POS	USM2usD1_POS	POS_AppDmpPH	POS_AppDmpSH	POS_PrTnkPH3	POS_PrTnkSH3
POS_MoiTCbH1	POS_MoiTCbH2	POS_USM3_L04	POS_USM4_L04	POS_USM5_L04	POS_USM6_L04
POS_IMUexPH	POS_IMUexSH	USM3usD1_POS	USM4usD1_POS	USM5usD1_POS	USM6usD1_POS
POS_PFDPU_1	POS_PFDPU_2	POS_SEP1inPH	POS_SEP1inSH	POS_PF_bpPH	POS_PF_bpSH
USM1usD2_POS	USM2usD2_POS	POS_RWA3_PH	POS_RWA3_SH	POS_PLZ3_PH	POS_PLZ3_SH
POS_ST1exPH	POS_ST1exSH	POS_Batt1iH1	POS_Batt1iH2	POS_PLZ4_PH	POS_PLZ4_SH
POS_CDH_PH	POS_CDH_SH	USM3usD2_POS	USM4usD2_POS	USM5usD2_POS	USM6usD2_POS
POS_HeLZ1PH	POS_HeLZ1SH	POS_USM3_L08	POS_USM4_L08	POS_NGM_isH1	POS_NGM_isH2
POS_USM1_L09	POS_USM2_L09	POS_SEP2inPH	POS_SEP2inSH	POS_PLZ9_PH	POS_PLZ9_SH
POS_RWA1_PH	POS_RWA1_SH	POS_NGM_Sw1P	POS_NGM_Sw1S	POS_RSDPU_P	POS_RSDPU_S
USM1usD3_POS	USM2usD3_POS	POS_NGM_Sw2P	POS_NGM_Sw2S	USM5usD3_POS	USM6usD3_POS
POS_TagIG_PH	POS_TagIG_SH	USM3usD3_POS	USM4usD3_POS	POS_SAobDmPH	POS_SAobDmSH
POS_ST2exPH	POS_ST2exSH	POS_TcmTvPH	POS_TcmTvSH	POS_HeLZ2PH	POS_HeLZ2SH
POS_USM1_L13	POS_USM2_L13	POS_LPW1BmPH	POS_LPW1BmSH	POS_USM5_L15	POS_USM6_L15
POS_PrTnkPH1	POS_PrTnkSH1	POS_LPW2BmPH	POS_LPW2BmSH	POS_TagOG_PH	POS_TagOG_SH
USM1usD4_POS	USM2usD4_POS	POS_TWTAbpPH	POS_TWTAbpSH	POS_TAME_1	POS_TAME_2
POS_SDST_1	POS_SDST_2	USM3usD4_POS	USM4usD4_POS	USM5usD4_POS	USM6usD4_POS
POS_SDSTexPH	POS_SDSTexSH	POS_SWIAinPH	POS_SWIAinSH	POS_Cb1458PH	POS_Cb1458SH
POS_HeTnk_H1	POS_HeTnk_H2	POS_Cb2367PH	POS_Cb2367SH	POS_EUTexPH	POS_EUTexSH
POS_USM1_L18	POS_USM2_L18	POS_PAPU_PH	POS_PAPU_SH	POS_PCAplaPH	POS_PCAplaSH
POS_USM1_L19	POS_USM2_L19	POS_PIA_PH	POS_PIA_SH	USM5usD5_POS	USM6usD5_POS
USM1usD5_POS	USM2usD5_POS	USM3usD5_POS	USM4usD5_POS	POS_EUV_inPH	POS_EUV_inSH
POS_USM1_L20	POS_USM2_L20	POS_IMU_1	POS_IMU_2	POS_NGM_ibH1	POS_NGM_ibH2
POS_RS_isH1	POS_RS_isH2	POS_SAibDmPH	POS_SAibDmSH	POS_SWEAdmPH	POS_SWEAdmSH
POS_EUT_Sw1P	POS_EUT_Sw1S	POS_Tv3456PH	POS_Tv3456SH	USM5usLT_POS	USM6usLT_POS
POS_EUT_Sw2P	POS_EUT_Sw2S	POS_IUVSisH1	POS_IUVSisH2	POS_PLZ5_PH	POS_PLZ5_SH
USM1usLT_POS	USM2usLT_POS	USM3usLT_POS	USM4usLT_POS	POS_PLZ6_PH	POS_PLZ6_SH
POS_MAG1_InH	POS_MAG2_InH	POS_PF1Act	POS_PF2Act	POS_PLZ7_PH	POS_PLZ7_SH
POS_LSO_1	POS_LSO_2	POS_LSO_3	POS_USM4_LT1	POS_PLZ8_PH	POS_PLZ8_SH
POS_USM1_LT2	POS_USM2_LT2	POS_USM3_LT2	POS_USM4_LT2	POS_MoiTvPH	POS_MoiTvSH
POS_PLZ1_PH	POS_PLZ1_SH	POS_USM3_LT3	POS_USM4_LT3	POS_MoiTplPH	POS_MoiTplSH
POS_PLZ2_PH	POS_PLZ2_SH	POS_USM3_LT4	POS_USM4_LT4	USM5usLC_POS	USM6usLC_POS
POS_USM1_LT5	POS_USM2_LT5	POS_USM3_LT5	POS_USM4_LT5	POS_USM5_LC0	POS_USM6_LC0
USM1usLC_POS	USM2usLC_POS	USM3usLC_POS	USM4usLC_POS	POS_USM5_LC1	POS_USM6_LC1
POS_WTS1pos1	POS_WTS2pos1	POS_WTS3pos1	POS_WTS4pos1	POS_LPW1brP	POS_LPW1brS
POS_WTS1pos2	POS_WTS2pos2	POS_WTS3pos2	POS_WTS4pos2	POS_LPW2brP	POS_LPW2brS
POS_RWA1rON	POS_RWA2rON	POS_RWA3rON	POS_RWA4rON	POS_LPW1brrP	POS_LPW1brrS
POS_RWA1rOFF	POS_RWA2rOFF	POS_RWA3rOFF	POS_RWA4rOFF	POS_LPW2brrP	POS_LPW2brrS
POS_RWA4_PH	POS_RWA4_SH	POS_PrXdcrP	POS_PrXdcrS	POS_USM5_LC4	POS_USM6_LC4
POS_USM1_LC5	POS_USM2_LC5	POS_USM3_LC5	POS_USM4_LC5	POS_USM5_LC5	POS_USM6_LC5
USM1usHC_POS	USM2usHC_POS	USM3usHC_POS	USM4usHC_POS	USM5usHC_POS	USM6usHC_POS
POS_RWA_1	POS_RWA_2	POS_TWTA_1	POS_TWTA_2	POS_RWA_3	POS_RWA_4

7.1.7 SASM DRF file structure

The Solar Array Switch Module (SASM) files are DRF files containing information about the state of the solar arrays. There are SASM 1, 2, and 3 files.

Table 19: RS DRF data file record structure

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
SASM_SA_SW00, SASM_SA_SW01, SASM_SA_SW02, SASM_SA_SW03, SASM_SA_SW04, SASM_SA_SW05, SASM_SA_SW06, SASM_SA_SW07, SASM_SA_SW08, SASM_SA_SW09, SASM_SA_SW10, SASM_SA_SW11, SASM_SA_SW12, SASM_SA_SW13, SASM_SA_SW14, SASM_SA_SW15, SASM_SA_SW16, SASM_SA_SW17, SASM_SA_SW18, SASM_SA_SW19	The SASM (solar array switch module) solar array switch 00 through 15 register switch 00, 01, 02…19 status. See the SASM Design Description Document DDD-913G0194050-001 for additional details.
SA1pyISC	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 07. SASM 1 +Y ISC current. Corresponds to C-0107 (SA1pyISCcio). In DN and EU
SA1pyVOC	PDDU AAC (analog acquisition card) AIV (analog input voltage) channel 08. SASM 1 solar array plus Y, VOC voltage. Corresponds to C-0108 (SA1pyVOCcio). In DN and EU.

7.1.8 PTE file structure

The Periapsis Timing Estimator (PTE) DRF files contain information about the estimated periapsis times.

Table 20: PTE DRF data file record structure

Field Name	Description
SCET	Spacecraft Event Time in yy/ddd-hh:mm:ss.fff
GV_PteCumPDT	Indicates the cumulative periapse time correction. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) flight software.

GV_PteCurPTi	Indicates the SCLK time of the current periapsis. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) flight software.
GV_PteCurPer	Indicates the current orbital period. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) flight software.
GV_PteLstPTi	Indicates the SCLK time of the last periapsis. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) flight software.
GV_PteMxHtRt	Indicates the maximum heating rate. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) flight software.
GV_PteNxtPTi	Indicates the SCLK time of the next periapsis. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) flight software.
GV042_SPARE	Spare global variable 042.
GV_PteAbmCmd	Indicates that an apoapsis up burn in needed. Set by the AHR IN (inertial navigation) PTE (periapsis time estimator) software.
PTE_CUM_ACCL	The accumulated acceleration calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_ACCUM_DV	The accumulated delta velocity calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_CUR_PER	The current orbital period calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_NEXT_PER	The time of next periapsis calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_PER_RDUC	The orbital period reduction calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_P_T_CORR	The periapsis time correction calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_RAW_CORR	The periapsis time raw correction calculated by AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_START_T	The time at which the AHR IN (inertial navigation) PTE (periapsis time estimator) was started.
PTE_STATUS	Indicates the status of the AHR IN (inertial navigation) PTE (periapsis time estimator).
PTE_VAL_DATA	The number of valid data sets counted by the AHR IN (inertial navigation) PTE (periapsis time estimator) counted at a rate of 10 Hz.
PTE_MxAcDens	Indicates the maximum atmospheric density as calculated by AHR IN (inertial navigation) using the accelerometers.
PTE_MxRwDens	Indicates the maximum atmospheric density as calculated by AHR IN (inertial navigation) using the reaction wheels.
PTE_PTTindex	Indicates the index into the PTT (periapsis time table) of the currentl periapse time and orbit period.
PTE_RwAxis	Indicated the PTE (periapsis time estimator) reaction wheel axis.

7.1.9 IMU file structure

Event files are ASCII tables with data organized in columns.

Table 21: Event data file record structure

Field Name	Description
IMU_TIME_@_TONE	
IMU_TIME	
GIFCT	
FRMCNT	
STATWD	
XANGLE	Cumulative change in direction for the X, Y, and Z gyros with 1 count being 1e-6 radians. Orientations wrt the MVN body frame are given in the Coordinate Systems Definitions Document, MAV-RP-10-0100
YANGLE	
ZANGLE	
XACCEL	Cumulative change in velocity of the X, Y, and Z accelerometers. Orientation and location are in the Coordinate Systems Definitions Document. Each count is 7.53e-5 m/s.
YACCEL	
ZACCEL	
MUX	

7.1.10 Event data file structure

Event files are ASCII tables with data organized in columns.

Table 22: Event data file record structure

Field Name	Description
id	Event ID: unique ID for each event.
event_type_id	Event type code.
start_time	Event start time.
end_time	Event end time.
source	Event source: science, MAVEN Integrated Report, or SPICE kernels.
description	Text description of event.
discussion	Notes from POC event database.
modified_time	Event creation time.
mission_event_id	Derived from POC event database; does not exist for science events.

7.2 PDS Labels

PDS labels are ASCII text files written, in the eXtensible Markup Language (XML). All product labels are detached from the digital files (if any) containing the data objects they describe (except Product_Bundle). There is one label for every product. Each product, however, may contain one or more data objects. The data objects of a given product may all reside in a single file, or they may be stored in multiple separate files. PDS4 label files must end with the file extension ".xml".

The structure of PDS label files is governed by the XML documents described in Section 7.2.1.

7.2.1 XML Documents

For the MAVEN mission PDS labels will conform to the PDS master schema based upon the 1.1.0.1 version of the PDS Information Model for structure, and the 1.1.0.1 version of the PDS schematron for content. By use of an XML editor these documents may be used to validate the structure and content of the product labels.

The PDS master schema and schematron documents are produced, managed, and supplied to MAVEN by the PDS. In addition to these documents, the MAVEN mission has produced additional XML documents which govern the products in this archive. These documents contain attribute and parameter definitions specific to the MAVEN mission. A full list of XML documents associated with this archive is provided in Table 4. A list of the XML documents associated with this archive is included in this document in the XML_Schema collection section for each bundle.

Examples of PDS labels required for the ANC archive are shown in Appendix C (bundle products), Appendix D (collection products), and Appendix E (basic products).

7.3 Delivery Package

Data transfers, whether from data providers to PDS or from PDS to data users or to the deep archive, are accomplished using delivery packages. Delivery packages include the following required elements:

1. The package which consists of a compressed bundle of the products being transferred.
2. A transfer manifest which maps each product's LIDVID to the physical location of the product label in the package after uncompression.
3. A checksum manifest which lists the MD5 checksum of each file included in the package after uncompression.

ANC archive delivery packages (including the transfer and checksum manifests) for delivery to PDS are produced at the MAVEN SDC.

7.3.1 The Package

The directory structure used in for the delivery package is described in the Appendix in Section F.1. Delivery packages are compressed using zip and are transferred electronically using the ssh protocol.

7.3.2 Transfer Manifest

The "transfer manifest" is a file provided with each transfer to, from, or within PDS. The transfer manifest is external to the delivery package. It contains an entry for each label file in the package, and maps the product LIDVID to the file specification name for the associated product's label file. Details of the structure of the transfer manifest are provided in Section 0.

The transfer manifest is external to the delivery package, and is not an archive product. As a result, it does not require a PDS label.

7.3.3 Checksum Manifest

The checksum manifest contains an MD5 checksum for every file included as part of the delivery package. This includes both the PDS product labels and the files containing the digital objects which they describe. The format used for a checksum manifest is the standard output generated by the md5deep utility. Details of the structure of the checksum manifest are provided in section F.3.

The checksum manifest is external to the delivery package, and is not an archive product. As a result, it does not require a PDS label.

Appendix A Support staff and cognizant persons

Table 18: Archive support staff

SDC			
Name	**Address**	**Phone**	**Email**
Alexandria DeWolfe SDC Manager	LASP, University of Colorado 1234 Innovation Drive Boulder, CO 80303	303-492- 6835	alex.dewolfe@lasp. colorado.edu

UCLA			
Name	**Address**	**Phone**	**Email**
Dr. Steven Joy PPI Operations Manager	IGPP, University of California 405 Hilgard Avenue Los Angeles, CA 90095-1567 USA	+001 310 825 3506	sjoy@igpp.ucla.edu
Mr. Joseph Mafi PPI Data Engineer	IGPP, University of California 405 Hilgard Avenue Los Angeles, CA 90095-1567 USA	+001 310 206 6073	jmafi@igpp.ucla.edu

Appendix B Naming conventions for MAVEN science data files

This section describes the naming convention used for science data files for the MAVEN mission.

Raw (MAVEN Level 0):

mvn_<inst>_<grouping>_l0_< yyyy><mm><dd>_v<xx>.dat

Level 1, 2, 3+:

mvn_<inst>_<level>_<descriptor>_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.<ext>

Code	Description
<inst>	3-letter instrument ID
<grouping>	Three-letter code: options are all, svy, and arc for all data, survey data, and archive data respectively. Primarily for PF to divide their survey and archive data at Level 0.
<yyyy>	4-digit year
<mm>	2-digit month, *e.g.* 01, 12
<dd>	2-digit day of month, *e.g.* 02, 31
<hh>	2-digit hour, separated from the date by T. OPTIONAL.
<mm>	2-digit minute. OPTIONAL.
<ss>	2-digit second. OPTIONAL.
v<xx>	2-digit data version: is this a new version of a previous file, though the same software version was used for both? (Likely to be used in the case of retransmits to fill in data gaps)
r<yy>	2-digit software version: which version of the software was used to create this data product?
<descriptor>	A description of the data. Defined by the creator of the dataset. There are no underscores in the value.
.<ext>	File type extension: .fits, .txt, .cdf, .png
<level>	A code indicating the MAVEN processing level of the data (valid values: l1, l2, l3)

Instrument name	<instrument>
IUVS	iuv
NGIMS	ngi
LPW	lpw
MAG	mag
SEP	sep
SWIA	swi
SWEA	swe
STATIC	sta
PF package	pfp

Appendix C Sample Bundle Product Label

This section provides a sample bundle product label.

Appendix D Sample Collection Product Label

This section provides a sample collection product label.

Appendix E Sample Data Product Labels

This section provides sample product labels for the various data types described in this document.

Appendix F PDS Delivery Package Manifest File Record Structures

The delivery package includes two manifest files: a transfer manifest, and MD5 checksum manifest. When delivered as part of a data delivery, these two files are not PDS archive products, and do not require PDS labels files. The format of each of these files is described below.

F.1 Transfer Package Directory Structure

/maven/data/anc/eng/eps/
/maven/data/anc/eng/gnc/
/maven/data/anc/eng/imu/
/maven/data/anc/eng/ngms/
/maven/data/anc/eng/pf/
/maven/data/anc/eng/pte/
/maven/data/anc/eng/rs/
/maven/data/anc/eng/sasm1/
/maven/data/anc/eng/sasm2/
/maven/data/anc/eng/sasm3/
/maven/data/anc/eng/usm1/
/maven/data/anc/eng/usm2/
/maven/data/anc/eng/usm3/
/maven/data/anc/eng/usm4/
/maven/data/anc/eng/usm5/
/maven/data/anc/eng/usm6/
/maven/data/anc/events/

F.2 Transfer Manifest Record Structure

The transfer manifest is defined as a two field fixed-width table where each row of the table describes one of the products in the package. The first field defines the LIDVID of each product in the package. The second field defines the file specification name of the corresponding product label in the package. The file specification name defines the name and location of the product relative to the location of the bundle product.

F.3 Checksum Manifest Record Structure

The checksum manifest consists of two fields: a 32 character hexadecimal (using lowercase letters) MD5, and a file specification from the root directory of the unzipped delivery package to every file included in the package. The file specification uses forward slashes ("/") as path delimiters. The two fields are separated by two spaces. Manifest records may be of variable length. This is the standard output format for a variety of MD5 checksum tools (*e.g*. md5deep, etc).